Art. VIII.—*Notes on the Geology of Moorooduc in the Mornington Peninsula.*

By ERNEST W. SKEATS, D.Sc., A.R.C.S., F.G.S.

Professor of Geology, University of Melbourne.

(With Plates XIV.-XVI.).

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Introduction.

My first visit to the neighbourhood of Moorooduc was made in 1905, in the company of my assistants, Messrs. H. J. Grayson and H. Summers, and the members of the Geological Field Class of the University. On this visit we were concerned mainly with three problems:—

1. The age of the Palæozoic sediments which rise above the mantle of Tertiary rocks.

2. The characters of the granitic mass of Mt. Eliza and of the acid veins proceeding from it.

3. The nature of the metamorphism effected by the intrusion to the granitic rocks into the Palæozoic sediments.

This first visit enabled us to obtain evidence bearing on the two latter questions, but we shared the fate of previous observers in failing to find any fossils, so that the age of the rocks remained in doubt. A second visit made under similar auspices in 1906 was more successful, as recognisable fossils were obtained.

The present communication is based partly on field-work during these visits and a later examination, and partly on a petrological determination of the granitic and metamorphic rocks.

Previous Literature.

The first published account of the geology of the district is included in a report made by Selwyn, entitled: —"Report on the Geology, Palæontology and Mineralogy of the country situated between Melbourne, Western Port Bay, Cape Schank and Point Nepean, accompanied by a geological map and sections." This was published in the Votes and Proceedings of the Legislative Council of Victoria, 1854-5, vol. I.

Two years later Selwyn published a fuller report on the district, which was accompanied by a more detailed map.

Two statements in the earlier paper have reference to the rocks of the Mooroodue district. On page 7 he describes the oldest rocks of the area, and in the absence of fossils ascribes them on lithological grounds to the Older Palæozoic series. He recognised four lithological types among these rocks. One type, "seen only on the flanks of Mt. Eliza, Mt. Martha and Arthur's Seat," he described as "very hard crystalline felspathic grey-brown and red micaceous sandstones, and beds of hard, dark-blue indurated slates and shales . . . and their crystalline character is probably due to alteration caused by the intrusion of the granite forming these hills."

The granites of the district he referred to on page 8 as "presenting no peculiar features, being composed of quartz, reddish-coloured felspar and black mica; the two latter, however, occasionally vary in colour, the mica being yellow and the felspar white." On his second map, printed in 1856, Selwyn records the cast of an encrinite stem from Sandstone Island in Western Port, and the rocks are referred to the Silurian period.

The next paper bearing on the area was by Mr. A. E. Kitson, F.G.S., entitled. "Report on the coast line and adjacent country between Frankston, Mornington, and Dromana," and was published in March, 1900, in Monthly Progress Report No. 12 of the Department of Mines, Victoria. Mr. Kitson gives an interesting and somewhat detailed account of the geology of the district, and the report is accompanied by sections and a geological sketch map of the area described. Mr. Kitson does not describe the plutonic mass of Mt. Eliza, but refers to the

acid dykes which penetrate the sedimentary rocks in a quarry north of Mooroodue Railway Station. He notes that they have indurated the contiguous strata for distances ranging from less than an inch to several feet. He describes most of the dykes as aplites, and makes the interesting observation that the muscovite and biotite in the dykes line the walls, while the centres consist of the more acid quartz and felspar. He gives a lithological description of the sediments, and refers to the spotted character of the thin bedded micaceous shales. The rocks are described under the heading "Silurian" by Mr. Kitson, and the same view is expressed in the large Geological Map of Victoria of 1902. Mr. Kitson, however, remarks that the rocks resemble in some respects the graptolite-bearing shales of the Lancefield district, and "they may eventually prove to be of Ordovician age, though the Silurian belt may be the extension of the Upper Silurian of the Melbourne district."

In the year 1900, Mr. Evelyn Hogg published a paper entitled, "The Petrology of certain Victorian granites."[1]. Mr. Hogg does not discuss the granitic rock at Mt. Eliza, but describes one from an adjoining locality, Frankston, as a medium-grained granitite, a rock with pink felspar, orthoclase and plagioclase being about equally represented, quartz and biotite. The rock of Watson's Quarry, Mt. Martha, lying south of Mt. Eliza, is described as a medium-grained syenite. As these are the nearest granitic masses to Mt. Eliza, their composition is of some interest in this connection. It is to be noted, however, that Mr. Hogg defines a granitite as including all holocrystalline quartz-biotite, rocks in which a monoclinic felspar is not the dominant one, while he defines a syenite as a normal granite with hornblende. Most petrologists would now, I think, describe such a rock as a hornblende granite.

In 1901, Messrs. T. S. Hall and G. B. Pritchard published a paper in the Proceedings of the Royal Society of Victoria, Vol. XIV., N.S., Pt. 1, entitled "Some Sections Illustrating the Geological Structure of the Country about Mornington." They go fully into the previous literature of the area, and the greater part of the paper is devoted to the detailed discussion of the Tertiary rocks and fossils of the district. The rocks of the Mooroodue quarry

1 Proc. Roy. Soc. Vict., n.s., vol. xiii., 1900, p. 218.

are described as Silurian or Ordovician. In this paper we have the first indication that the palæozoic rocks are fossiliferous They describe a coarse conglomerate which underlies the older basalt in many places as being "derived in the main from the older palæozoic sedimentary rocks of the district, and from the granitic series. In two places—namely, in the first cutting on the coast road south of Frankston, and near the first outcrop of granite rock south again from this place on the shore, we have found a few graptolites in slate pebbles. They are very indistinct, and beyond saying that they are species of Diplograptus, we do not at present care to venture. Their evidence, then, leaves the age of the rocks still open."

In the year 1904 the first definite record of fossils found "in situ" in the older Palæozoic rocks of the Mornington Peninsula was given by Mr. T. S. Hall, M.A.[1] The record does not mention the finder of the fossils, but I understand that it was Mr. W. H. Ferguson, of the Geological Survey of Victoria. The first record is that of the occurrence of Climacograptus and Diplograptus in boulders from Grice's Creek, Mornington, a locality nearer to Mooroodue than the earlier finds of Messrs. Hall and Pritchard. The evidence of these fossils, however, still leaves the age of the beds doubtful. A second suite of fossils found "in situ" at Balnarring, and identified by Mr. Hall, shows clearly that Lower Ordovician rocks occur in that part of the Mornington Peninsula. Mr. Hall records

Didymograptus, c.f. pritchardi.
Tetragraptus approximatus.
Tetragraptus quadribrachiatus.
Tetragraptus fruticosus (*?*).
Ostracoda.

Mr. Hall states that if the identification of T. fruticosus (*?*) is correct, the age of the rocks is Bendigonian, and in any case cannot be higher than the horizon of Castlemaine. Another series of fossils from Bulldog Creek, near Dromana, yielded to Mr. Hall the same forms as those from Balnarring, and in addition undoubted specimens of Tetragraptus fruticosus, thus fixing their Bendigonian horizon.

1 Reports on Graptolites, Records of Geological Survey of Victoria, vol. i., pt. iii., 1904, pp. 220, 221.

Didymograptus, sp. indet.
Temnograptus, sp.
Dendrograptus (?).
Rhinopterocaris maccoyi.
Brachiopod cast,

and indeterminate Hexactinellid sponge spicules were also recognised from among the collection made by Mr. Ferguson at this locality. The credit, then, for first finding fossils "in situ" in the Palaeozoic rocks of the Mornington Peninsula belongs to Mr. Ferguson, and for determining their Lower Ordovician (Bendigonian) age to Mr. Hall.

The Age of the Older Sedimentary Rocks of Mooroodue.

The foregoing account of the geological literature dealing with the district shows the progress already made towards determining the age of the Palæozoic rocks of the Mornington Peninsula. The records from Balnarring and Bulldog Creek definitely established the Lower Ordovician age of the rocks of the southern part of the Mornington Peninsula, but the age of the series near Mooroodue remained still in doubt, as it lies about ten miles to the north of the localities mentioned above, and, moreover, the graptolites found in the boulders of the conglomerates of Grice's Creek and near Frankston showed only that the rocks might be Ordovician or Lower Silurian.

The area near Mooroodue does not look promising, as apart from the highly altered rocks in the quarry north of Mooroodue station, rock exposures are very few, and several observers had already searched the locality with negative results. This also was our experience in 1905, but on the second visit in 1906 we were more fortunate. We were searching the hillside about a third of a mile north-east of the large quarry at about an elevation of 350 feet above sea level, and almost due west of a slight bend in the road which runs north towards Frankston. Here the uprooting of a tree had exposed a very limited area of the slates, and from this and another small exposure close at hand we found a number of graptolites. They were clearly of Lower Ordovician age, as forms belonging to Didymograptus and Tetragraptus were recognised. On returning to Melbourne I

submitted the collection to Mr. Hall for more detailed examination, and he has kindly identified the followings forms:—

Didymograptus caduceus, Salter.
Tetragraptus serra (sensu stricto) Brongn.
Diplograptus, sp.
Trigonograptus, sp.
Lasiograptus, sp.
Glossograptus, sp.

Also specimens of Rhinopterocaris maccoyi, Eth. fils., and sponge spicules.

Mr. Hall adds the following notes:—"The horizon is that of the Upper Castlemaine series, although the presence of Glossograptus is suggestive of the horizon of the Darriwill series. The species of Diplograptus is similar to one which occurs as low down as the Victorian Gully beds at Castlemaine, but is indistinct. Trigonograptus is known from higher beds, but possibly occurs at Castlemaine. The presence of graptolies in the Eocene (?) conglomerate on the beach near Frankston has been recorded by Mr. Pritchard and myself.[1] We announced the presence of Diplograptus, but ventured no further. At the same time I found a specimen which I thought might be Didymograptus caduceus, but it was so indistinct that I thought it wiser not to mention it, especially as the record of even the genus would have upset the generally-received opinion as to the age of the slates of the district." The discovery of these graptolites provides the evidence previously wanting for determining the age of the Mooroodue rocks, clearly shows their Lower Ordovician character, and Mr. Hall's determinations show that the rocks belong to the Upper Castlemaine, or possibly the Darriwill series, a higher horizon than that of the graptolite bearing rocks previously described from the southern part of the Peninsula. It is now probable that all the slates and sandstones of the Mornington Peninsula belong to the Ordovician series. The graptolites were found on a steeply sloping part of the hillside, where no observations of the dip or strike of the beds could be obtained. At a lower level the Ordovician rocks pass below the Tertiary series, the general direction of the eastern boundary of

1 Proc. Roy. Soc. Vict., xiv., 1901, p. 41.

the hill being N. 60 deg. E. On walking south-westwards towards the large quarry, further search gave negative results. The rocks of the quarry are in places much disturbed. On the south-western face of the quarry a steep anticlinal fold is seen, and towards the N. end an abrupt change of strike to E. and W., and a dip to N. at 70 deg. is noticed, while at the south end, where the beds are less disturbed, the strike is nearly N.E. and S.W., and the dip N.W. at 80 deg. At the opposite or North-east face of the quarry the strike was observed to be N. 20 deg. E., and dip E. 20 deg. S. at 70 deg. Possibly the rocks of the quarry belong to the same series as those in which the graptolites were found, as a continuance of the N. 20 deg. E. strike would pass close to the graptolite localities.

The Metamorphic Rocks of the Mooroodue Quarry.

The rocks consist of sandstones and slates. The sandstones, some of which occur in fairly thick beds, show little visible alteration except that in places they are changed to quartzite. The slates are, however, highly altered. Among the slates are some with alternate dark and light laminae. On splitting a specimen of laminated slate along a bedding plane, elongated colourless prismatic crystals up to an inch in length were seen. A fragment of one of these crystals examined under the microscope shows the refractive index, polarization colours, and pink to colourless pleochroism characteristic of andalusite.

Thin sections of the slates show the occurrence of two types, the one more, the other less altered. The less altered type is a spotted slate (Sections 505A and 506B). Under the microscope crypto-crystalline to micro-crystalline aggregates of a white micaceous mineral are seen to form abundant lighter areas with sub-rectangular boundaries, while the fine-grained groundmass consists of biotite, quartz, uniaxial white mica, hematite, limonite, and some dark red-brown rutile crystals.

The white uniaxial mica is possibly bleached biotite, since some of the larger crystals have apparently unaltered brown areas parallel to the cleavage traces, while hematite and limonite surround the white mica in such a way as to suggest that the iron has been leached from biotite and deposited as oxide round the

bleached cystals. Several sections of another mineral are present. It occurs as colourless prismatic sections, showing minute fluid and other inclusions, with high refractive index and low polarization colours which are grey to yellow, of the first order. Two cleavages are noticed, a well-defined one parallel to the longer axis of the crystal, and a less well developed one at right angles to this. A few sections showed straight extinction, but the majority extinguished in an oblique position. The maximum extinction angle observed was 43 deg. from the longer axis. It is invariably associated with a marginal colourless mineral of lower refractive index and higher polarization colours. This mineral extends inwards from the margins of the crystals, and appears to be an alteration product consisting of a white uniaxial micaceous mineral. Most of the sections of the mineral show the emergence of an optic axis in a somewhat oblique position. The mineral is andalusite. The sections are too thin to exhibit the characteristic pleochroism, and the high angle of extinction noticed in some sections is to be connected with the large optical axial angle exhibited by this mineral.[1]

The more altered type of slate (Section 507) shows complete recrystallization of the clastic materials. The rock consists mainly of a number of interlocking quartz granules and micaceous minerals. The latter include biotite, muscovite and bleached biotite (?). No trace of a spotted structure is seen, but the original bedding planes are defined by lines along which there is a greater concentration of biotite and hematite, and larger crystals of the micas occur along these laminæ. Among the minor constituents minute rutiles occur, and a few pleochroic granules of tourmaline, which have been included in the bleached micas. Andalusite is not represented in this rock.

These altered rocks, containing an abundance of micas, are evidently rich in alkalies. It is therefore probable that in the formation of the shale the alkali contents were not leached out as sometimes happens. It must be remembered, however, that the alkali contents of the shales may have been reinforced by thermal solutions passing out from the margin of the granitic intrusion.

1 The numbers of the rock sections refer to the University collection of rock slices.

The Grano-Diorite and Apophyses of Mount Eliza.

The Apophyses.—These have only been noticed in the metamorphosed slates and sandstones of the large Mooroodue quarry, about three-quarters of a mile north of Mooroodue railway station. They consist of acid extrusions from the plutonic mass, and vary from fine-grained aplitic rocks to fairly coarse pegmatites. The largest vein seen measured about three feet in width. They are all somewhat decomposed, and on that account no rock sections have been made from them. In places quartz and felspar alone are present, in others biotite and muscovite also occur, usually in large flakes up to three-quarters of an inch in length, and in one or two cases black tourmaline was noticed.

Mr. Kitson has drawn attention[1] to the most interesting feature in connection with them—viz., the general concentration of the mica along the walls of the veins, the central parts being relatively free from that mineral. The small sizes of the veins makes it improbable that convection currents have played any part in the marginal grouping of the micas. This arrangement may be referred to as an illustration of a process first investigated by Soret[2] in the case of crystallization from aqueous solutions. He showed that if a constant difference of temperature is maintained between two parts of a vessel containing a saturated solution, crystallization will proceed at first only in that part of the vessel which is at the lower temperature. Mr. Teall[3] has sought to explain the concentration of the earlier formed basic minerals on the walls of some ingenous intrusions in terms of Soret's principle.

The disposition of the mica flakes in the acid veins of the Mooroodue quarry may probably be referred to the same cause.

The Grano-diorite.—The plutonic mass of Mt. Eliza extends as a somewhat elliptical shaped mass just over two miles long from N.E. to S.W., and about a mile across in the widest part in a N.W. S.E. direction. Most of this area is covered with a mantle of granite detritus, and only two or three limited outcrops are seen of the rock "in situ." The best exposure occurs

1 Op. cit.

2 Ann. Chim. Phy., Paris, 1881, (5) 22, p. 293.

3 British Petrography, p. 402.

in a shallow quarry near the summit of the hill. The rock is grey, fairly even grained, and felspar, quartz, black biotite and a little hornblende are visible in the hand specimen. Its specific gravity is 2.69. Under the microscope (Section 504) it is noticed that both plagioclase and orthoclase are present, that some of the biotite has been altered to chlorite, abundant needles of apatite are included in the generally ragged crystals of biotite, and a little rutile is probably present. The symmetrical extinction angles of the plagioclase lamellæ range from about 11 deg. to 17 deg. The crystals are frequently zoned, the margins being invariably more acid, and are sometimes untwinned. The central parts of the crystals correspond to andesine of composition Ab_5An_3, the margins to oligoclase of composition Ab_4An_1. The average composition of the plagioclase as a whole is probably near Ab_9An_5. The plagioclase is generally somewhat kaolinised, and is usually idiomorphic. The orthoclase, containing some minute irregular intergrowths with albite is, however, fresh and moulded on the plagioclase. The structure of the rock, as a whole, is hypidiomorphic, and the average grain-size is 1 mm.

Petrographically, it should be classed with a number of other Victorian granitic rocks as a grano-diorite, on account of the large amount of quartz present, the considerable quantity of an alkali felspar, and the relatively acid character of the plagioclases present in this group of rocks. Professor Gregory,[1] following American usage, has suggested the application of this term in preference to Quartz-mica-diorite, to which group Dr. Howitt has referred some of them.

No chemical analysis of this rock is available, but an attempt has been made to determine, quantitatively, its mineral volume composition. From this the bulk mineral composition is found by multiplying the percentage volume of each mineral by its specific gravity. Finally, by accepting analyses of minerals having similar optical properties, an attempt has been made to determine approximately the chemical composition of the rock.

The method followed in determining the volume percentage of each mineral in the rock is due to Rosiwal.[2] He has used a

1 The Geology of Mount Macedon, Victoria, Proc. Roy. Soc. Victoria, 14 (1902), p. 192.

2 Verhandl d.k.k. Geol Reichsanst. 1898, pp. 143, et seq. The Quantitative Classification of Igneous Rocks, 1903, p. 204. J. P. Iddings, Journal of Geology, vol. xii. (1904), p. 252.

travelling stage or eye-piece micrometer to obtain a number of traverses across a microsection, and has shown that the volumes of the different minerals are proportional to the sums of their intercepts or any line or lines drawn across the rock, if the number of minerals traversed be sufficient. Applying this method, it was found that, out of a total length of 1035 units, the sums of the intercepts of the different minerals were as follows:—

The percentage volumes are shown in the second column:—

Plagioclase	414	40
Quartz	305	29.47
Orthoclase	198	19.13
Biotite	113	10.91
Hornblende	5	0.48
Apatite (estimated)	2.5	0.24
		100.23

The specific gravities of the minerals is taken to be as follow:—

Plagioclase (Ab_9 An_5)	= 2.65
Orthoclase	= 2.55
Quartz	= 2.65
Biotite[1]	= 2.99
Hornblende	= 3.28
Apatite	= 3.20

Multiplying the percentage volumes of the minerals by their densities we obtain the proportions by weight which are then recalculated as percentages.

	Gravimetric proportions.	Percentage Mineral Composition.
Plagioclase	106.00	39.87
Quartz	78.09	29.37
Orthoclase	46.78	17.59
Biotite	32.62	12 23
Hornblende	1.57	.59
Apatite	.80	.30
	265.86	99.95

1 The specific gravity of the Biotite was determined from flakes by immersing them in Sonstadt's heavy liquid, and determining by the Westphal balance the specific gravity of the liquid in which they floated in any position. The composition of the Biotite is assumed to be similar to that of Chebarkul of similar specific gravity (see Dana's System of Mineralogy, p. 630), while the Hornblende is assumed to be similar to that from a Vesuvian locality.

The plagioclase is assumed to have the composition $Ab_9\ An_5$. Distributing the 39.87 per cent. among these two molecules we obtain Albite 25.63 per cent., Anorthite 14.24 per cent.

Knowing the chemical composition of all the minerals and the percentage of each mineral present we arrive at the ultimate chemical composition of the rock.

Percentage Mineral Composition.	Orthoclase.	Anorthite.	Albite.	Quartz.	Biotite.	Hornblende.	Apatite.	Percentage Chemical Composition.
—	17.59	14.24	25.63	29.37	12.23	.59	.30	—
SiO_2	11.38	6.15	17.62	29.37	4.70	.24	—	69.46
Al_2O_3	3.24	5.24	5.00	—	1.76	.09	—	15.33
Fe_2O_3	—	—	—	—	.66	.01	—	.67
FeO	—	—	—	—	1.80	—	—	1.80
MgO	—	—	—	—	2.00	.07	—	2.07
CaO	—	2.86	—	—	—	.08	.20	3.14
K_2O	2.96	—	—	—	1.00	—	—	3.96
Na_2O	—	—	3.00	—	.07	—	—	3.07
P_2O_5	—	—	—	—	—	—	·10	.10
H_2O	—	—	—	—	.13	—	—	.12
						Total	-	99.72

In this mineralogical analysis, apart from the small experimental error in the traverses and estimation of the volume composition of the minerals of the rock, there are two sources of ambiguity. The Biotite analysis from Chebarkul, chosen for comparison on account of similar specific gravity, is that of a variety in which ferrous and magnesia oxides are present in almost equal amounts. The biotite in this grano-diorite may not have these oxides present in similar proportions. The other ambiguity rises from the fact that no allowance has been made for the small quantity of albite irregularly intergrown with the orthoclase. If this could be allowed for, potash would be slightly diminished and soda correspondingly increased in amount. Apart from these possible sources of error, it is believed that the figures fairly represent the chemical composition of the rock. Although the indicated silica percentage is higher than in some of the Victorian grano-diorites, the high total of the alkaline earths and the lack of preponderance of the potash

in the alkalies, shows that it should be grouped with the granodiorites rather than the granites or granitites. An analysis of the granodiorite from two miles N. or Dandenong township is appended for comparison.[1]

	Grano-diorite Mount Eliza.		Grano-diorite N. of Dandenong.
SiO_2 - - -	69.46	-	63.38
Al_2O_3 - -	15.33	-	17.36
Fe_2O_3 - -	.67	-	1.61
FeO - - -	1.80	-	1.98
MgO - - -	2.07	-	1.80
CaO - - -	3.14	-	4.18
K_2O - - -	3.96	-	.31
Na_2O - -	3.07	-	4.07
P_2O_5 - -	.10	-	.54
H_2O - - -	.42	-	CO_2 1.13
			Fes 3.38
	99.72		99.74

Summary and Conclusion.

1. This paper discusses the sedimentary, igneous and metamorphic rocks of Mooroodue, in the Mornington Peninsula, Victoria.

2. The previous literature on the area is discussed. Chronologically arranged, the salient features so far as they bear on this communication are as follow:—

1856. Selwyn finds a cast of an encrinite stem on Sandstone Island, Western Port, and indicates the age of the older sedimentary rocks of the district as Silurian on his geological map.

1900. A. E. Kitson suggests a lithological resemblance between the older sedimentary rocks of Mooroodue and the L. Ordovician rocks of Lancefield. He also notes the localization of the micas in the acid veins from the granite to the walls of the intrusion.

1900. Evelyn G. Hogg describes petrologically the granite rocks of areas adjoining Mt. Eliza. Some are described as "granitite," others as "syenite."

1 Geology of Mount Macedon, Proc. Roy. Soc. Vict., 14 (1902), p. 201.

1901. T. S. Hall and G. B. Pritchard discover Diplograptus in pebbles of Eocene (?) conglomerates near Frankston.

1904. T. S. Hall identifies graptolites found by W. H. Ferguson "in situ" at Balnarring, 10 or 12 miles south of Mooroodue. Tetragraptus fruticosus and other L. Ordovician forms are noted, and the horizon is described as Bendigonian.

3. *The Age of the Sedimentary Rocks of Mooroodue.*

The following L. Ordovician graptolites were found by me "in situ" in 1906, in slates three-quarters of a mile north of Mooroodue railway station, and identified by Mr. T. S. Hall:—

Didymograptus caduceus, Salter.
Tetragraptus serra (sensu stricto), Brongn.
Diplograptus, sp.
Trigonograptus, sp.
Lasiograptus, sp.
Glossograptus, sp.

Mr. Hall fixed their horizon as Upper Castlemaine, or possibly Darriwill. The discovery at Balnarring, and this later one at Mooroodue makes it probable that all the slates and sandstones of the Mornington Peninsula are of Ordovician age.

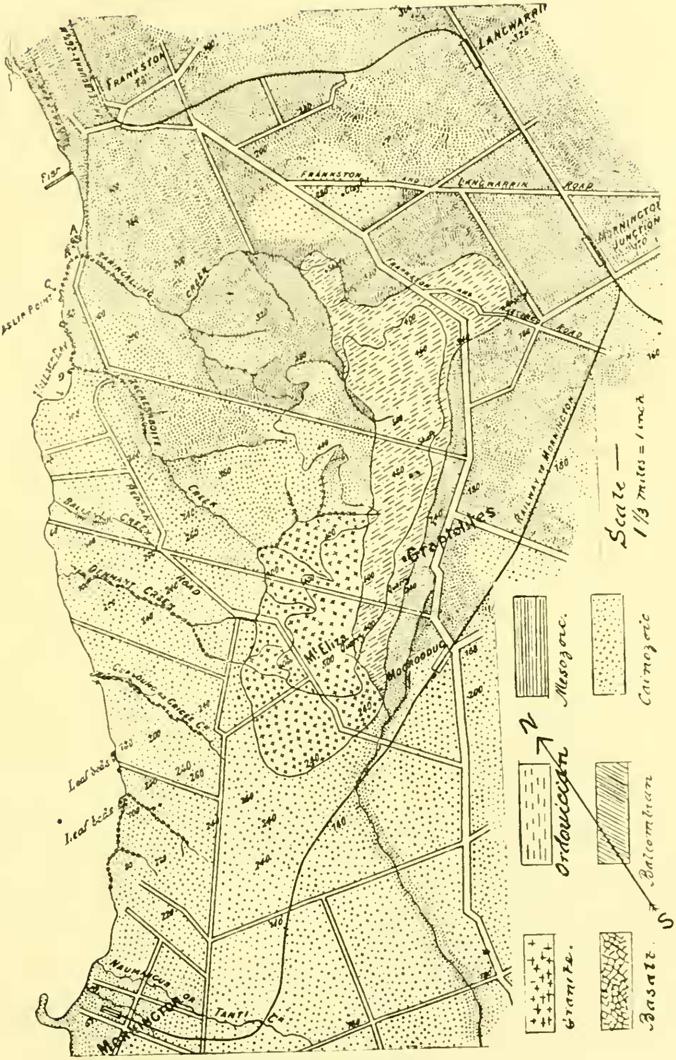
4. *The Metamorphic Rocks.*

Near the intrusive granite highly altered micaceous slates occur. One type is spotted, and contains andalusite showing high extinction angles. In the other type the recrystallization is more complete, although the bedding planes are still traceable. Rutile and tourmaline occur as accessory constituents, while bleached biotite (?) muscovite and biotite are abundant.

5. *The Grano-diorite and Apophyses.*

The Apophyses.—These are aplites and pegmatites. It is suggested that the concentration of the micas near the walls of the veins provides an illustration of the application of Soret's principle to igneous intrusions.

The Grano-diorite.—The rock is a hypidiomorphic, even-grained grano-diorite of Specific Gravity 2.69. In order of decreasing abundance the minerals present are:—Plagioclase,


Frankston
Langwarrin
Frankston and Langwarrin Road
Mornington Junction
Railway to Mornington
Graptolites
Mt Eliza
Moorooduc
Mornington
Leaf beds
Leaf beds
Granite.
Basalt
Ordovician
Balcombian
Mesozoic
Cainozoic
N
S
Scale — 1 1/3 miles = 1 inch